Chapter 7: Elements of Deterioration

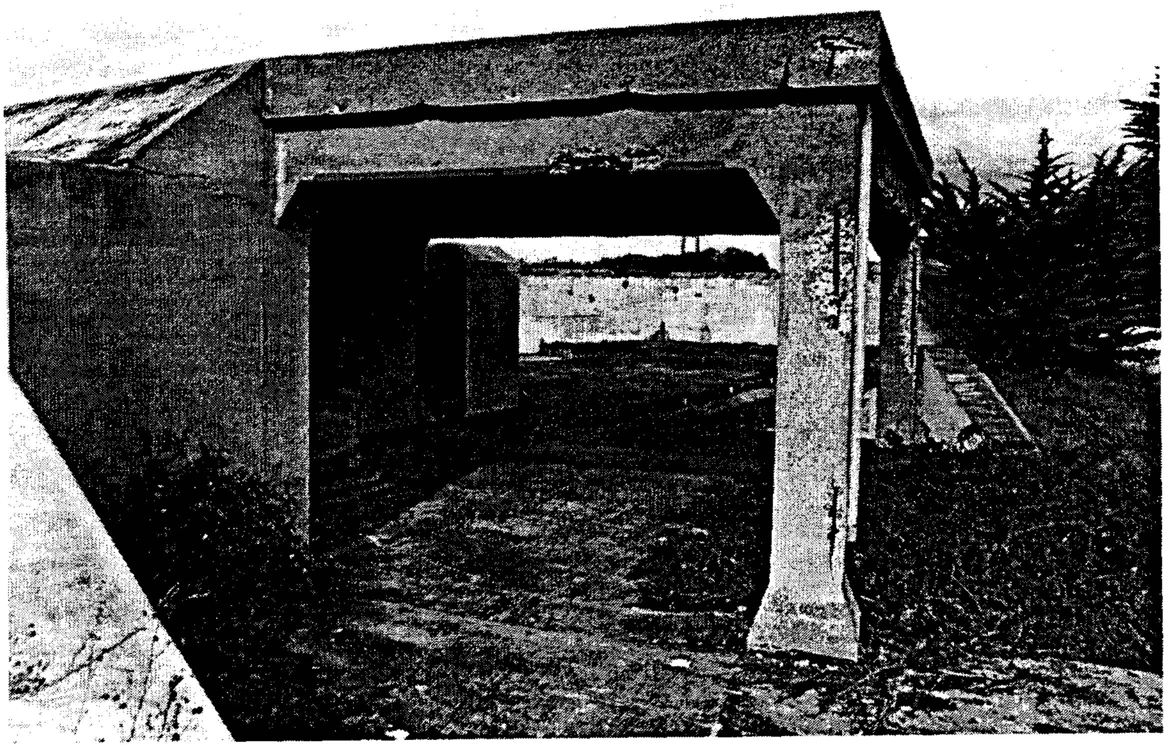

Plate 47. Concrete spalling is evident in the splinterproof at Battery Crosby, Fort Winfield Scott, constructed 1899-1900. Splinterproof added between 1904 and 1912.

Just as the fortifications reflect the evolution of fixed weapons from smooth-bore cannon to large caliber rifled guns and missiles, the fortifications show an evolution of construction methods and materials that parallel technological innovations that occurred from the Civil War to the Cold War (Plate 47). Construction methods and logistics such as roads for access, materials storage and handling, and water and power for construction permanently altered the immediate building sites and the surrounding landscape. Beyond the design influences of terrain, armament, and military doctrine, the fortifications represented mastery of traditional brick masonry construction, experimentation with plain and reinforced concrete construction during its formative period, and ultimately proficiency in advanced reinforced concrete construction.

The U.S. Army Corps of Engineers was well-informed about advances in the technology of limes, mortars, and cements both in the United States and in Europe in the latter half of the nineteenth century. Indeed, the military's interest paralleled early experimentation in the development of Portland cement in England and Europe and the Rosendale cements in the United States. Due to the limitations in the quality, consistency, and quantity of naturally occurring cements, military engineers sustained a keen interest in the manufacture of kilns, rock crushers, testing methods, structural calculations, and in new uses for cementitious materials. The value of cement in military construction was obvious. When combined with sand, gravel, crushed stone, and water in proper proportions, cement became concrete. Concrete had enormous structural advantages, particularly in resisting compressive forces. But concrete was found to be weak in resisting tensil forces. The U.S. Army Corps of Engineers was aware of concrete's tensil limitations and had been following French experiments that placed tension-resisting metal within the compression-resisting concrete. The French called the reinforced concrete mix *beton agglomere.*

Concurrent developments in steel manufacture, and an understanding that certain steel configurations could span great distances, led to the replacement of wooden structural elements in situations requiring long spans. The Chicago fire of 8 October 1871 pointed out the benefits of fireproof construction and lead to the combination of steel I-beams with either hollow tile or concrete to produce fireproof floor and roof systems. The parallel developments of fireproof construction and the combining of concrete and reinforcing steel to create a material that resisted both tension and compression merged near the end of the nineteenth century to form reinforced concrete, a material that would change the building culture of the twentieth century. That the U.S. military was an early observer, experimenter, and builder in reinforced concrete was not an accident of history; rather, it was the result of fifty years of attention by the U.S. Army Corps of Engineers. That attention would have profound effects that changed the military fortifications from brick masonry construction to one that relied heavily on reinforced concrete at the end of the nineteenth century.

In 1871, as an example of the military's concern with the technological possibilities of both concrete and steel, Quincy Adams Gillmore of the U.S. Army Corps of Engineers issued a report on *beton agglomere* under *Professional Papers, Corps of Engineers, U.S. Army, No.19.* In the report Gillmore discusses the raw materials, characteristics, and potential uses of an experimental material that would become known as reinforced concrete. Beyond its general use in construction, Gillmore noted that *beton* could be "used in fortifications, for foundations, generally, both in and out of water; for the piers, arches, and roof surfaces of casemates; for parade and breast-height walls, for counterscarp walls and galleries; for scarp walls, except those that shield guns; for service and storage magazines; for pavements of magazines, casemates, galleries, &c, and generally for all masonry not exposed to direct impact of an enemy's shot and shell." Gillmore's reservations about exposing *beton* to direct fire may reflect both a lack of understanding of reinforcement and ongoing experiments into impact-absorbing earthen fill configurations.

Existing Conditions

Causes of Deterioration

The historic and architecturally significant coast fortifications in the Golden Gate National Recreation Area have been exposed to a harsh environment high in moisture and salt. Built largely on seismically and structurally unstable soils and steep slopes, the fortifications have experienced all of nature's destructive forces except for the damaging effects of regular freeze-thaw cycles. In addition to wind loads, salt-laden moisture, and seismic instability, the fortifications have suffered from intrusive vegetation, vandalism, general neglect, and a lack of regularly scheduled maintenance. Methods used to construct the fortifications were themselves characterized by change, primarily due to steadily advancing experimentation at the batteries. Brick masonry and concrete construction, used in association with earthworks, dominate the construction materials. The relatively small number of materials used in the fortifications, and their consistency of design and construction techniques within distinct periods, however, is a counterpoint to the irregularity of historic construction methods over multiple periods—and as such offers an advantage in developing a treatment program.

Deterioration may be caused by a single condition or by the combined effect of a number of conditions acting together. Based on the building types, materials, and environment, the following causes of deterioration are present and typical:

1. Erosion by wind and/or water.
2. Seismic movement or soil instability.
3. Moisture infiltration.
4. Salt- and moisture-related corrosion.
5. Thermal expansion and contraction.
6. Intrusive vegetation.
7. Inherent design and structural deficiencies.
8. Removal of building elements.
9. Lack of regular maintenance.
10. Vandalism.
11. Visitor impact.

Identifying Characteristics

Preliminary identification of deteriorated conditions requires review of drawings and associated documents, visual inspection, and analysis. Deterioration may be recognized by the following indicators:

1. Presence of moisture.
2. Discoloration, staining, efflorescence.
3. Cracking within a material.
4. Cracking or separation at joints of different materials.
5. Sagging, deflection, or material failure.
6. Material loss, spalling, surface erosion, or exfoliation.
7. Accumulation of soil or organic matter at or on building elements.
8. Mildew, fungus, or plant growth.

Some signs of deterioration may not be readily apparent due to vegetative cover, soil covering, or the nature of the original construction. While the indicators of deterioration, listed above, may suggest active deterioration of a specific kind, the exact location and extent of deterioration requires more careful analysis. Indications of deterioration may also suggest that testing is required. Indications of deterioration usually do not occur in isolation but in related groups. Recognition of patterns of related elements of deterioration is critical to understanding active and latent deterioration and taking appropriate corrective action.

General Conditions Assessment

The historic and architecturally significant buildings and structures that comprise the coastal fortifications around San Francisco Bay have suffered extensive past deterioration and continue to suffer from the effects of active deterioration. Historic engineering records, in the form of annual reports from the Secretary of War, reported deterioration even as the batteries were under construction. Original architectural and engineering drawings for a number of the batteries were marked with specific recommendations for maintenance. Despite the effects of nature, historic use, and abandonment, the batteries and supporting facilities retain significant integrity of materials, context, and association.

The consistency of the materials and construction techniques within each period leads to a certain consistency in the elements of deterioration. A general assessment of condition includes the following material-specific items:

Earthworks

Bermed earthworks, built in association with masonry or concrete batteries were placed so as to absorb impact of shells and to blend, or hide, fortifications from view. Earthworks are in generally good condition with isolated erosion and soil instability. Seismic activity and erosion have undermined some smaller concrete structures at Battery Townsley and Battery Crosby. Battery Mendell was placed on an eroding sand hillside and has developed serious structural problems. Other batteries including Battery Boutelle exhibit major cracking. Trails often contribute to erosion. At most batteries, soil migration and washing have affected surface drainage by obstructing positive drainage away from structures and filling surface and subsurface drainage systems.

Vegetation

Fortification sites were greatly disturbed during initial construction. Natural topographic profiles were altered and vegetation was planted to reduce erosion and provide natural camouflage. Existing vegetation is not fully original to the sites. Vegetation has overgrown most of the sites to the extent that it has obscured character-defining features. And while grasses and low vegetation have had some beneficial effect by holding soil materials in place, larger trees have caused structural deterioration. Large tree roots threaten both masonry and concrete structures. In addition, surface vegetation provides a host for insects and the accumulation of moisture.

Brick Masonry

Original brick masonry, typically found in the post-Civil War period, remains in generally sound condition with isolated brick surface deterioration and mortar joint deterioration. Bricks at Cavallo Battery and Ridge Battery show signs of surface spalling in areas of exposure and stress. Mortar joint deterioration of the Portland cement mortar materials is localized to areas that have been exposed to wet-dry cycles. Some mechanical actions such as expansion and contraction have caused loss of mortar in the joints. Vandalism and graffiti have had the most damaging effect on extensive amounts of historic brickwork at Cavallo Battery. Spray paint, applied in multiple layers, will require drastic intervention to remove or mitigate.

Concrete

Plain and reinforced concrete at the fortifications has experienced moderate deterioration due to moisture infiltration, intrusion of vegetation, inherent concrete defects, soil movement, and corrosion. Concrete deterioration, while isolated, requires complex and expensive measures to arrest active deterioration and to preserve and restore surfaces and configurations to original lines. Many concrete problems may be hidden within masses of concrete and may be detectable only through testing. Concrete deterioration is visible in the forms of cracks, spalls, separations, material loss, rusting reinforcing steel, the presence of moisture, and stains related to moisture.

Metals

Metals, in the form of inset reinforcing steel, metal hardware, window bars, handrails, fittings, ladders, doors, gun mounts, and anchor bolts are in fair condition due to corrosion caused by moisture, the salt-rich environment, and galvanic action caused by contact between dissimilar metals. Many metal elements, including handrails, have been removed.

Wood

Wooden elements in the coastal fortifications are limited to wood doors, windows, frames, and isolated superstructures. Superstructures include framing, roof decking, and trim. Wooden doors, of slab and beaded board construction with metal straps and hardware, are typical through the Endicott and Taft periods Wood superstructures can be seen at Battery Spencer (latrine), the meteorological station at Fort Baker, and at the observation post below Point Bonita Lighthouse. The wood is in generally poor condition from the effects of vandalism, moisture, and rot.

Waterproofing

Asphalt waterproofing, originally applied to concrete surfaces in contact with earth and protected by hollow clay tile, is in unknown condition. Although waterproofing conditions are hidden by earthworks, it would be reasonable to expect degradation of the asphalt materials due to age. In some cases erosion has exposed edges of waterproofing coatings and tile. The superior slope at Battery Godfrey is an example of this type of erosion.

Roofing

Roofing is limited to isolated, small buildings (such as those at Battery Spencer and some observation posts) and is usually either a built-up "tar and gravel" roof or organic, granular surfaced roll roofing. Roofing materials are in poor condition. A number of unsealed bare concrete roofs are in fair condition.

Doors and Windows

All wood doors and windows, and wood door and window frames, were found to be in poor condition from moisture and vandalism. Metal doors were found to be in fair condition with active deterioration in progress from the effects of moisture and corrosion. In some cases metal doors have been welded shut and in other cases metal plates have been installed for security.

Coatings

Camouflage Coatings: Few examples of camouflage coatings remain. Those that do remain are in very poor condition. Remnants of an early (1890s) camouflage treatment can be seen at Battery Duncan, Battery Dynamite, and Antiaircraft Battery No. 1. Other remnants of camouflage coatings remain in varying states of deterioration.

Other Coatings: Other coatings used on the fortifications include standard military paint coatings, primers, and finish coats, for concrete, wood, and metal.

Ventilation

Ventilation of interior spaces at batteries and associated buildings has been limited due to the closure of doors and windows for reasons of security and the incapacity of original mechanical and gravity ventilation systems. The lack of ventilation has resulted in the accumulation of moisture within interior spaces. The failure to dissipate accumulated moisture has led to increased corrosion of reinforcing steel, imbedded metal items, and fixed and mounted metal equipment. Closure of openings for security reasons has contributed to moisture problems related to lack of vent.

Trails

Existing hiking trails associated with the fortifications are in fair to poor condition. Trails are often not clearly defined or marked, are overgrown with vegetation, and often have steep slopes. Some batteries and associated structures are enclosed by fences for security reasons and lack access. Trails have also contributed to erosion problems.

Maintenance

No active cyclical maintenance program appears to be directed at the fortifications. The fortifications are subject to infrequent condition inspections and irregular maintenance and repair.

Interiors

Interior spaces at Battery Chamberlain and Battery Wallace have been the subject of preservation and interpretive activities. But most spaces have been sealed or are not otherwise accessible. Drawings and limited inspection reveal that interior spaces are generally utilitarian spaces with simple wall coatings of whitewash, unfinished, or painted concrete. In some cases floors are finished in vinyl composition tile. The interiors have suffered primarily from moisture infiltration and lack of ventilation. Interior surface coatings have been damaged by moisture penetration through exterior walls and roof structures.

Levels of Treatment

Architectural treatment is governed by provisions of *The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings* (1995). These standards set forth appropriate treatment for historic buildings and structures. As a general guideline for treatment, the standards limit treatment in order to retain original historic fabric, character-defining features, and integrity. Architectural treatment, whether interim stabilization, preservation, or full repair and restoration, is dependent on what treatment is appropriate for a particular period in order to express original construction and use. Other factors affecting treatment include funding and interpretation. Each period, post-Civil War, Endicott and Taft, World Wars I and II, and Cold War, has distinct character-defining features. And although each period may have distinct characteristics, many fortifications saw use in more than one period.

Three general treatment levels are available and allow flexibility in planning, funding, and interpretation.

Stabilization

Control deterioration in order to retain historic configurations and materials. Stabilization may involve using temporary, intrusive, non-historic means that are reversible.

Preservation

Control and arrest deterioration in order to retain historic configurations and materials using appropriate means. Preservation seeks to maintain existing historic materials with only limited replacement of missing or deteriorated materials.

Repair and Restoration

Control and arrest deterioration while replacing missing or deteriorated materials using historically appropriate materials and means. Although restoration can be specific to a period, it may also include modifications that occurred in later historical periods. Restoration seeks to replace missing elements and to renew or replace severely deteriorated elements. Some modern materials and methods may be required due to the severity of the conditions encountered.

Common Treatment

Certain treatments are common to stabilization, preservation, and restoration. These treatments, however, may vary in scope according to intentions:

1. Site Cleaning: Remove trash and debris from the site.
2. Vegetation Removal: Trim back vegetation from contact with concrete and masonry materials and remove from the site. Remove dead wood and trees with harmful root growth.
3. Limited Earthwork: Remove soil wash from surface drainage paths. Establish adequate surface drainage away from structures.
4. Drains: Clean out cast concrete gutters and downspouts and coordinate with surface drainage.
5. Ventilation: Establish a ventilation program that regularly vents interior spaces by use of mechanical fans and/or natural convection.
6. Security: Increase site monitoring by appropriate means.